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A CONTRIBUTION TO THE MORPHOLOGY AND DEVELOPMENT OF CORYMORPHA PENDULA AG.

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THE following paper on the morphology and development of *Corymorpha pendula* was undertaken at the suggestion of Dr. C. W. Hargitt, for whose kindly criticism and suggestions throughout its progress it is a pleasure to express my obligation.

The purpose of these observations is to investigate some of the more fundamental morphological features of this hydroid; to trace the origin and development of the Medusa and to inquire briefly into the origin of the sex cells and the phenomena associated with oögenesis.

Corymorpha, in all the synopses of the Hydroidea which I have examined, is described as a solitary form, but in the material which was placed at my disposal, my attention was early called to the presence of what appeared to be definite colonial buds arising from the hydrorhiza. Acting upon the suggestion of Dr. Hargitt that it might be an interesting problem to determine whether these associated forms were true buds or mere parasites, I have begun my study with an investigation of the nature and relation of these forms.

Methods. — The specimens at my disposal were collected by Dr. C. W. Hargitt at Wood's Holl, Mass., during the summer of 1900. Several methods of killing and preserving were used. My best results were obtained from material killed in corrosive acetic acid. Formalin and Flemming's solution gave less satisfactory results.

In the study of general histological features I found that *in toto* staining in borax carmine was both a satisfactory and convenient method. Specimens might be left in the stain from 10 to 48 hours and then the stain extracted to any desired degree in 1% acid-alcohol. Dehydration required from one to two hours. For clearing, cedar oil, clove oil, xylol or turpentine were used; xylol or turpentine proving most satisfactory.

In the study of the developmental features a number of sections were stained on the slide with iron-hæmatoxylin. Combinations of iron-hæmatoxylin and Bordeaux red, and of eosin and hæmatoxylin were used with good success.

In the former combination sections were placed in a 2% solution of ammonio-ferric-alum for from thirty minutes to four hours. After this they were washed for several minutes in running water and then stained in a 5% aqueous solution of hæmatoxylin for from one to three hours. They were then again washed in running water and again treated with the iron solution, which slowly washed out the stain, until a satisfactory differentiation was obtained. After rinsing the sections in water they were stained from fifteen minutes to one half hour in Bordeaux red, carried up through the alcohols and mounted in balsam.

In the eosin-hæmatoxylin method sections were first stained from one to two hours in a 2% solution of alcoholic eosin and then from five to fifteen minutes in a weak solution of Delafield's hæmatoxylin.

Associated forms. — As stated in the introduction, one of the first things that was called to my attention in taking up the study of the morphology of *Corymorpha pendula*, was the presence of a smaller hydroid associated with it. These smaller forms have all the appearance of true buds. In some cases they are found attached to the hydrocaulis, and in others they are observed springing up from within the tangled network of rhizoidal filaments. Wishing to discover something as to the true relations of these forms, I made a series of transections of the stem of Corymorpha in the region of these supposed buds in order to determine whether, in the first place, there was any organic connection between them. A study of these sections revealed no such organic connection whatsoever. The base of the smaller hydroid was in all cases buried only in the perisarc of Corymorpha and generally separated from the ectodermal layer by a considerable thickness of perisarc.

Upon taking off some small portions of the perisarc of Corymorpha bearing these supposed buds, staining with borax-carmine and mounting whole, a peculiar modification of the base of these smaller hydroids was observed. The stem after it has penetrated the perisarc for a short distance, expands and gives off a number of lateral finger like projections extending through the perisarc in various directions.

Further examination also proved that the stem is annulated for a considerable portion of its length and that the cœnosarcal canals so characteristic of Corymorpha are entirely lacking.

From these observations it is quite clearly evident that we have here distinct forms instead of true colonial buds, thus confirming the usual descriptions of Corymorpha as a solitary form.

This species, however, I have not been able to find described in any of the synopses of the Hydroidea. From its morphology it is evidently a tubularian. Dr. Hargitt has suggested for the species the name *parasitica*, and as such it has recently been described by him. Torrey (:02) has expressed the opinion that these forms are undoubtedly clusters of young individuals of Corymorpha. This view would seem to be precluded not only from a consideration of their morphological characteristics, but from the fact that all the specimens examined were of about the same size, and some of them even began to show signs of sexual maturity.

Corymorpha pendula.

External Morphology. — L. Agassiz ('62, p. 276) says, "This hydroid is not found along our shores as are the other tubularians, but may be obtained by dredging in deeper water on a sandy or muddy bottom. In some localities it is quite plentiful. It has been collected in three different places, all within Massachusetts bay." Specimens have been taken off "Crab Ledge," Chatham, in the deep waters of Muskeget Channel and in Vineyard Sound. The natural position of this hydroid is an upright one. Hargitt (:01, p. 313) describes this hydroid as "bright pink in color, medusæ light yellowish, manubrium, tentacles and bulbs pinkish."

Corymorpha is always found as a solitary form, never budding nor giving rise to colonies. The stems grow to a height of from six to ten centimeters and reach a maximum diameter just a little above the proximal extremity. Toward both extremities, the diameter decreases; the stem tapering gradually toward the distal end, where it terminates in a short blunt point. The stem is invested in a very delicate, filmy, colorless perisarc, which in the upper region of the stem is very closely applied, but below becomes separated from it by a very considerable space, forming here a sort of loose fitting corrugated sac over the blunt point of the basal extremity. The stem is seen to be traversed by a series of longitudinal bands which anastomose with one another here and there, and which represent, as we shall see later, a series of canals hollowed out in the entoderm. From the lower region of the stem there grows out a large number of short papilliform processes. The hydrorhiza consists of a tangled network of numerous thread-like filaments.

The hydranth is somewhat flask shaped, the neck of the flask being represented by the flexible proboscis at the distal extremity of the hydranth. In the centre of this proboscis is found the mouth surrounded by from seventy-five to eighty-five closely set tentacles arranged in a number of irregular whorls, and having somewhat the appearance of a brush. About the base of the hydranth is a single circle of very much larger tentacles varying in number from twenty-five to thirty.

The medusoids are arranged in closely crowded clusters borne upon slender branched pedicels which arise from the body of the hydranth immediately above the proximal set of tentacles. There are from fifteen to twenty-five of these medusoid-bearing branches.

HISTOLOGY OF PARTS.

(*a*.) *Hydrocaulis*. — The perisarc: — The perisarc presents the appearance of a thin, semi-transparent film. This film is considerably thicker about the basal portion of the stem than it is in the distal region where it becomes so thin and delicate as to be almost lost to sight.

Ectoderm: — The ectoderm, although its cellular structure was not especially well defined in some sections, is composed of a single layer of somewhat columnar cells with large and distinct nuclei, and filled with numerous granules. Among the cells of the ectoderm are to be found great numbers of small transparent cells, the developing nematocysts. These nematocysts seem to be most numerous and best developed in the tentacles.

Entoderm: — The entoderm is composed of two distinctly different kinds of cells whose disposition through the stem may be best understood by calling attention here to the peculiar modification which Corymorpha presents as regards the enteric cavity. In most hydroids this is represented by a hollow cœnosarc, its tubular cavity being central in position and communicating directly with the cavities of the polypes. In Corymorpha, however, this cavity is represented by a number of intercommunicating canals running longitudinally through the entire length of the stem. (Fig. 1, *m*.) The whole central axis of the stem is occupied by a column of parenchyma-like tissue composed of large, loose, vacuolated cells of an irregular polygonal shape. (Fig. 1, *a*.) These cells have very little contents with the exception of here and there a number of small nuclear corpuscles. Torrey (:02) refers to these entodermal cells as "skeletal cells"; and, as he suggests, this condition of peripheral canals and a solid entodermal axis, would seem to be, in view of the large diameter of Corymorpha, a "direct adaptation to size." The very delicate character of these cells might make the propriety of the term "skeletal" somewhat questionable. It seems quite probable, nevertheless, that these parenchyma-like cells do afford some support to the stem, but rather by imparting to it a sort of turgescence, than because they serve as a true, supporting skeletal framework.

The peripheral layer of entoderm, on the other hand, is composed of small sub-spherical cells filled with granular contents and possessing distinct nuclei. (Fig. 1, *b*.)

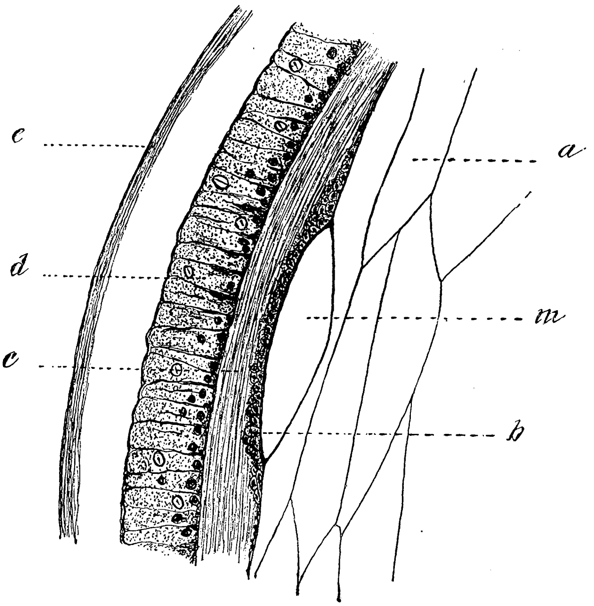

Fig. 1. Transection of stem of Corymorpha showing one of the cœnosarcal canals at *m*; *a*, inner layer of entoderm; *b*, peripheral layer of entoderm; *c*, mesoglœa; *d*, ectoderm; *e*, perisarc.

It is in a zone between these two kinds of entodermal cells that the longitudinal canals are excavated. These canals are simple tubular spaces lying between some of the entoderm cells and entirely devoid of anything like a specially differentiated wall. Above, these canals pursue their course through a cone like projection of the loose entoderm cells which extends for a considerable distance into the cavity of the hydranth proper. (Fig. 2, *a*.) Because of the lacunar nature of these canals, their course through the entoderm cone is somewhat indefinite. At the base of the cone, the canals converge and finally empty into a single median canal which is continued upwards to the apex of the cone. (Fig. 2, *b*.) I have not been able to get sections which show satisfactorily the course of this median canal, but I am inclined to think that it is continued up through the apex of the cone, thus finally communicating directly with the hydranth cavity.

Towards the base of the stem these canals become fewer and larger by union with each other, but finally disappear in a region just a little below the belt of papillæ.

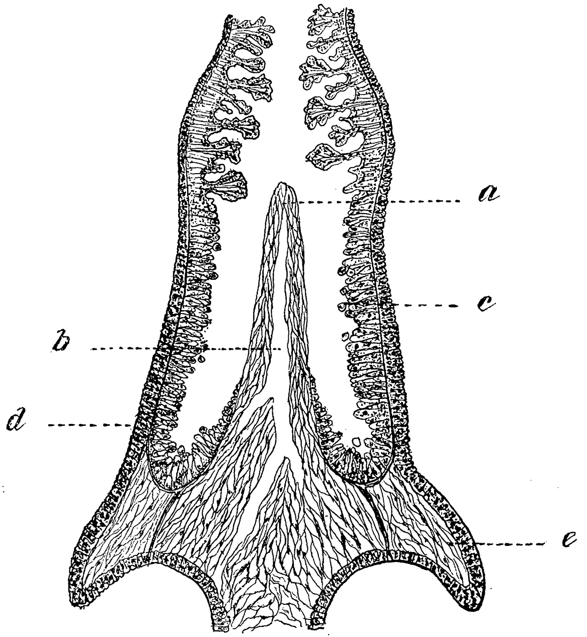

Fig. 2. Longitudinal section of hydranth showing core of entodermal cells at *a*, through which pass the longitudinal canals, *b*; *c*, gland cells of entoderm; *d*, ectoderm; *e*, tentacle.

For the purpose of comparison a series of transverse and of longitudinal sections of *Tubularia couthouyi* were made, and here was found a structure which in all essential features resembles what we have described in Corymorpha. The canals of Tubularia, however, are distinctly wedge shaped in transection with the apex of the wedge directed toward the center of the stem. In Corymorpha, the canals are oval or elliptical in transection. Moreover in Tubularia, the pith like core occupying the center of the stem is composed of small nearly spherical cells well filled with granular contents. There is no projection of the entodermal axis into the hydranth cavity as we found in Corymorpha.

A number of sections of *Tubularia larynx* were examined for further comparison. The structure of this species agrees in considerable detail with that of *T. couthouyi*.

Allman ('71, p. 205) describes a similar condition in *Tubularia indivisa*. He says: "The stem of Tubularia indivisa presents immediately within the perisarcal tube a continuous layer of ectoderm enclosing the endoderm, which extends to the very center of the stem and thus obliterates all trace of a central somatic cavity. The place of the cavity however is supplied by numerous canals which are excavated in the endoderm and take a longitudinal course through the stem, occasionally communicating by lateral offsets with one another and finally all merging in a common central cavity at the base of the hydranth." He further states that the canals are of unequal size, "one of them especially being in almost every instance considerably larger than any of the others." L. Agassiz ('62) says that a similar condition as to the size of the canals may sometimes be detected in *T. couthouyi*, although I was unable in my observations to perceive any appreciable difference in size.

(*b*.) *Papilliform processes.* — The lower part of the stem of Corymorpha is covered with numerous short conical papillæ arranged in an irregular longitudinal series and apparently following the course of the canals. Lower down toward the base of the stem these papillæ increase in length and in many specimens these small processes were seen in all stages varying from very short blunt papillæ above, to extremely elongate filaments below. Immediately below these processes are found the numerous filamentary rhizoids which cover the saccular portion of the perisarc. The presence of these two structures at the base of the stem and the apparent merging of the one into the other naturally suggests the problem as to their relation and derivation. Upon examination of transections of the stem in this region we find that these papillæ begin as simple outgrowths of the ectoderm. (Fig. 3.) At the same time the mesogloea directly underneath these outgrowths is seen to grow very much thinner, and in the course of development, to extend up into the papilla for a short distance as seen in Fig. 4 *c*. As the layer of mesoglœa is thus interrupted, the peripheral entodermal cells extend up into the papilla, forming a central axis of entoderm. L. Agassiz ('62) states that these papillæ are hollow and are permeated by prolongations of the chymiferous tubes of the stem. Allman ('71, p. 209) in a description of *C. nutans*, modifies this statement somewhat and says, "They *apparently* communicate with the canal over which they lie." From a study of a number of sections I have been unable to verify this statement of Agassiz. Not only do the papillæ very often lie in regions other than over the chymiferous canals — I have frequently found them growing out of an area of the stem between two canals — but all of the sections show the papillæ to be solid, composed of an ectoderm and a central core of entoderm. They are not hollow, but maintain this solid character even after they have grown into comparatively long filaments. (Fig. 5.)

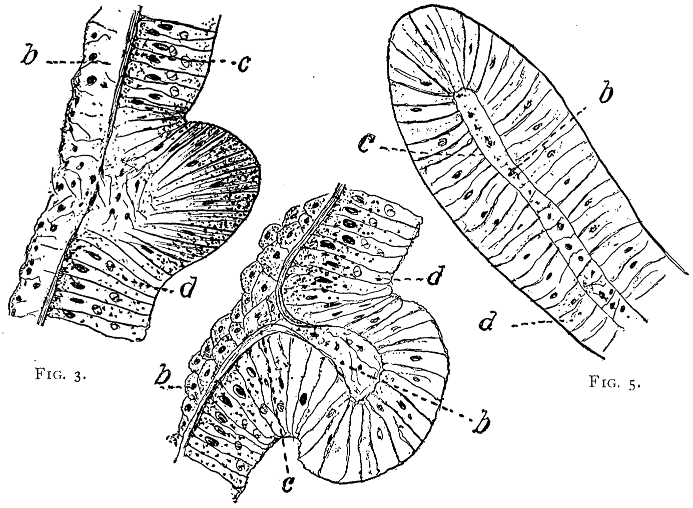

FIG. 3. FIG. 4. FIG. 5.

FIGS. 3, 4, 5 : — Successive stages in the development of the papilliform processes : *b*, entoderm ; *c*, mesoglœa ; *d*, ectoderm.

As these papillæ continue to grow and elongate, they finally break through the perisarc; a perisarcal sheath begins to be secreted about them, and their cellular structure becomes less distinct. As the hydroid now continues to grow, the perisarc, which in the younger stage was somewhat closely applied to the base, now becomes separated from it by a considerable distance, forming a loose corrugated sac over the proximal end. With the withdrawal of the coenosarc, the papillæ also sever their connection with the coenosarc. The living cellular portion now being separated from that of the main stem and hence devoid of any means of nourishment, disintegrates, leaving merely a hollow perisarcal tube in its place. Upon examining sections of the filamentary rhizoids, we find that they are mere hollow tubes of perisarc, terminating in an imperforate and somewhat clavate extremity. There thus seems to be no doubt that these rhizoids are but the products of secretion of the papilliform processes.

Allman. ('71, p. 209) referring to them says that these processes "have never been seen to act as organs of adhesion nor have we yet any evidence of the office they may serve in the economy of the animal, but it is impossible not to recognize in them structures having a close relation to the filaments of attachment which are given off from the stem a little lower down."

(*c.*) *Hydranth.*— The most striking histological feature of the hydranth is the presence of numerous and highly developed gland cells (Figs. 6, 7). The development of this remarkably specialized structure leaves little doubt that the function of digestion devolves especially upon this part of the hydroid cavity and that there are here structures set apart for the distinct purpose of secreting the digestive fluid. In the distal part of the hydranth cavity, the entoderm is thrown into a series of large and complicated folds or ridges whose surfaces are covered with these digestive gland cells. In the intervals between the ridges are often found smaller and less numerous cells whose protoplasm takes a denser stain than that of the surrounding cells. The free ends of the gland cells are seen projecting out into the hydranth cavity where their walls may often be seen ruptured and their contents sloughing off into the cavity of the hydranth. (Fig. 6, *a.*) Often the gland cells may be seen entirely separated from the parent tissue and projected bodily into the hydranth cavity. (Fig. 6, *b*). Toward the center and base of the hydranth cavity, the folds of the entoderm disappear, but the gland cells become decidedly larger and are found covering a considerable portion of the pith-like core which projects into the cavity as described above. The cells in this region are more elongated, with their broad ends projecting into the digestive cavity; the outer ends are rather narrow and tapering, and become merged in the converging ends of the neighboring cells. (Fig. 6.) These gland cells possess a distinct nucleus and nucleolus. The protoplasm often presents a finely alveolar structure. Lying in the protoplasm are numerous minute granules and very often granules of a larger size. The whole structure presents a striking similarity to the digestive epithelium of the larvæ of some of the insects. Needham gives a description of the digestive glands of dragon fly nymphs which corresponds in considerable detail with what we find in Corymorpha.

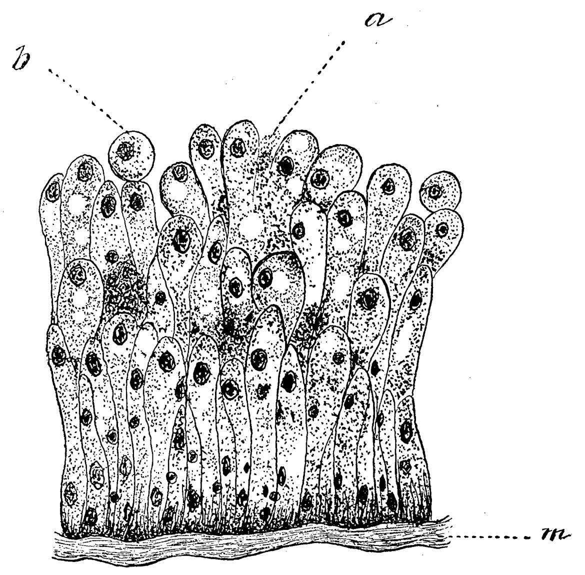

FIG. 6.— Portion of a transection through the basal region of hydranth showing *a*, gland cells sloughing off into hydranth cavity and *b*, others projected bodily into cavity; *m*, mesoglœa.

In Hydra and in most of the simpler hydroid polypes, the digestive cavity consists of a simple tube traversing the long axis of the body, but dilated in the region of the hydranth. The function of digestion is not limited to any particular region of this enteric cavity, but is carried on to a greater or less extent in all its parts. In Corymorpha, however, the enteric cavity does not remain a single tube, but becomes differentiated into secondary cavities having the character of pouches and canals. From the histological character of these extensions of the primitive digestive cavity, we see that they are not only morphological differentiations of the latter, but that they also correspond to distinct physiological differences. As stated above, the gland cells are highly developed in the hydranth, but are entirely absent from the cœnosarcal canals; that is, the physiological activity of the digestive cavity is not shared by the canals which arise from it, and the function of digestion has become localized. It would seem to be strongly probable that we have here a specific case of localized digestion and the subsequent distribution of its products by means of the cœnosarcal canals. The central primary space together with the accessory spaces constitutes what might be termed a gastro-vascular system, the cœnosarcal canals undertaking the function of a circulatory system. The gastric system in Corymorpha then may be distinguished from that of Hydra and of the simpler hydroid polypes by this exhibition of a higher differentiation.

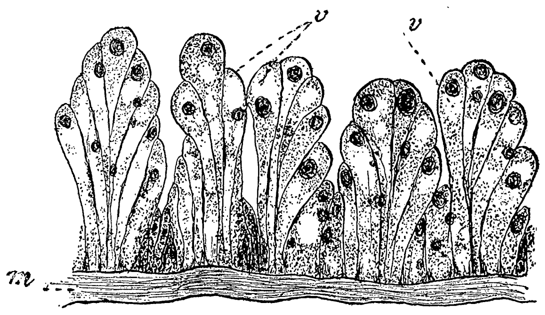

FIG. 7. — Portion of a transection through the distal region of hydranth, showing character of gland cells. *v*, vacuoles; *m*, mesoglœa.

(*d*.) *Tentacles*.—The ectoderm of the tentacles consists of short columnar cells with large distinct nuclei. Scattered among these cells are numerous large thread cells. The entoderm consists of large irregular polygonal cells which entirely fill up the axis of the tentacle. Toward the distal end, the entoderm cells become fewer and larger, their boundaries stretched transversely across the tentacle in longitudinal section, thus giving it a peculiar septate appearance.

The ectoderm and entoderm are separated from each other by a thin supporting lamella, the mesoglœa, which also separates the two layers of cells in other portions of the hydroid.

ORIGIN AND DEVELOPMENT OF THE MEDUSA.

The medusoids in this species are found at the extremities of a number of hollow branched peduncles. These peduncles are from fifteen to twenty-five in number and are arranged in two circles about the hydranth just above the proximal set of tentacles. On the same specimen will usually be found medusoids in various stages of development, from buds just forming, to rather mature Medusæ, together with intermediate stages. The general order of development of the medusa buds is centripetal, that is, the younger buds are usually found at the bases of the branches, while the older ones appear at the distal extremities of the branches.

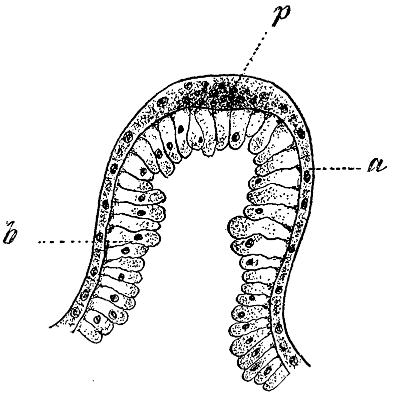

FIG. 8. — An early stage in the development of the medusa bud, showing the formation of germinal cells *p*, from the ectoderm *a*; *b*, entoderm.

The peduncles upon which the Medusæ are borne are simple hollow outpushings of the hydranth and are composed of the same layers — ectoderm, entoderm and mesogœla. In their development the medusa buds present essentially the same succession of phenomena which we find in other Tubulariæ. They begin as simple evaginations of the wall of the penduncle. (Fig. 8.) By a proliferation of the ectoderm cells in the distal end of the bud, a plug of ectodermal cells is formed which grows down into the medusoid cavity, forcing back the entoderm as it advances. This retreating fold of entoderm, as it doubles upon itself by the increased growth of the ectodermal plug, presses closely upon only four meridional areas of the stationary layer of entoderm. By this process, four equidistant spaces or chymiferous channels are left in direct communication with the medusoid cavity. These spaces constitute the beginnings of the radial canals. (Fig. 9, *c*.) As these channels continue to elongate, they become dilated at their extremities into bulb like expansions which evidently give rise to the circular canals. Early in the process of development, the entoderm, forces its way back through the center of the ectodermal plug to form the manubrium. (Fig. 9, *m*.) The mass of cells lying between the bell and the manubrium, and which are of ectodermal origin, give rise to the future reproductive elements. (Fig. 9, *g*.) The inner ectodermal layer of the bell, and the ectodermal layer of the manubrium arise as successive differentiations of the germinal layer. (Fig. 10, *i. c.*)

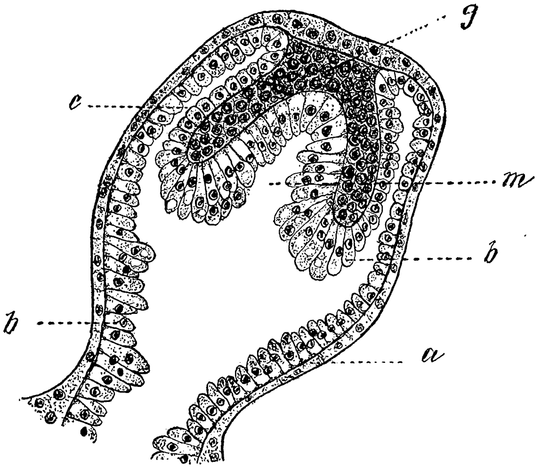

FIG. 9.—A later stage in the development of the medusa bud, showing the mode of formation of the manubrium *m*, and the radial canals *c*; *g*, germinal layer; *b*, entoderm; *a*, ectoderm.

L. Agassiz ('62, p. 278) says, "the medusa buds of this Hydroid do not become free individuals, but remain attached, develop their generative material and then wither and die."

A. Agassiz ('65, p. 193) on the other hand, in speaking of the Medusa of *Corymorpha pendula* says, "Although the separation of this Medusa from its Hydrarium has not been observed, yet their similarity to the most advanced Medusa buds observed on our Corymorpha, leaves but little doubt on this point." Torrey (:02, p. 38) in his observations on *C. palma* states that the gonophores do not become free. The eggs "drop from the Manumbrium of the attached Medusa" and "there is no free swimming larva." Dr. Hargitt tells me that in his mind there is no doubt that the gonophore sometimes becomes free. On a number of occasions hydroids have been taken by him, which

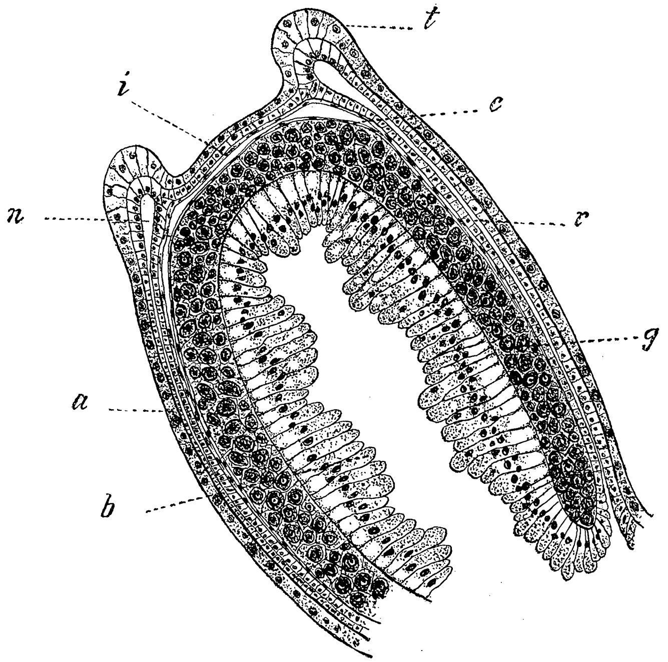

FIG. 10. — An advanced stage in the development of the medusa bud; *t*, tentacles; *n*, circular canal; *r*, radial canal; *g*, germinal layer; *a*, ectoderm; *b*, entoderm; *i*, inner ectodermal layer of bell; *c*, ectodermal layer of manubrium.

bore Medusæ in all stages of development, and at the same time, from waters close about where the hydroids were dredged, free medusæ. These Medusæ unmistakably belonged to Corymorpha and there seems to be but little doubt as to the indentity of their relations. We have here a condition just intermediate between the fixed and the free gonophore phases, a phenomenon not very uncommon among the Tubularidæ.

Oögenesis. — Between the manubrium and the bell is a large mass of cells, which as we have seen above, is derived from the ectoderm and is destined to give rise to the future reproductive elements. Brauer ('91, p. 575) in speaking of the origin of the genital products in *Tubularia mesembryanthemum* says, "Die Geschlechtsprodukte von Tubularia entstehen aus interstitiellen zellen des Ektoderms des Gonophorenträgers, sie treten nahe der Ursprungstätte eines Gonophors ins Entoderm über, wandern hier ihrer Reifungsstätte, dem ektodermalen Glockenkern, zu."

Weismann ('83) states that in some hydroids, the reproductive elements may originate in the cœnosarc of the trophosome. While this is very rarely the case in hydroids where a definite medusoid is developed, I have found one case where there appeared to be a small egg cell in the ectoderm of the stem. The cells of the germinal layer, especially in female gonophores, are a great deal larger than those of the surrounding layers. They are closely packed together, nearly spherical in form, and possess large distinct nuclei with prominent nucleoli. (Fig. 11, *a*.) For a time these cells all increase slightly in size, the protoplasm in the meantime becoming somewhat denser from the periphery toward the center of the cell. At this stage may generally be found four or five cells which are outstripping their neighbors in growth and are attaining a considerably greater size. These cells are destined to develop into mature ova and are found for the most part occupying a position next to the manubrium. They now assume a distinct amœboid form sending out a

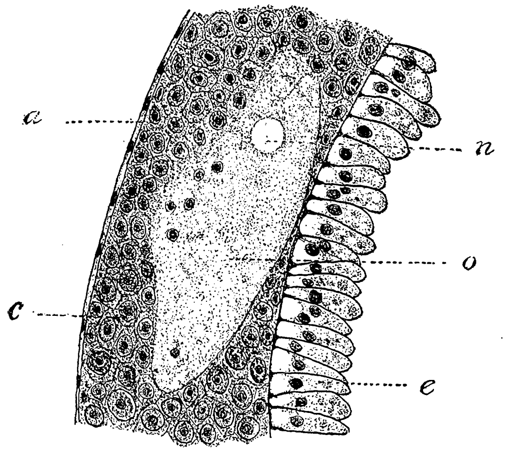

FIG. 11. — Portion of a transection through a late medusa bud showing the growth of the ovum by absorption of primitive egg cells; *o*, ovum; *n*, nucleus of ovum; *e*, entoderm; *a*, ectodermal layer of manubrium.

number of pseudopodia-like processes among the adjacent cells and finally absorbing them into their own substance. (Figs. 11, 12.) The phenomenon as I have observed it is essentially as described by Doflein ('96) for *Tubularia larynx.*

The boundaries between one of the large cells and those adjacent to it begin to break down. This large cell which, according to Doflein has had the advantage of position and nourishment, at once appropriates to itself the protoplasm of these surrounding cells. A syncytium with irregular outline is thus formed from the fusion of these cells, and in it may be detected for some time the disintegrating nuclei of the absorbed cells. (Fig. 12, *b.*)

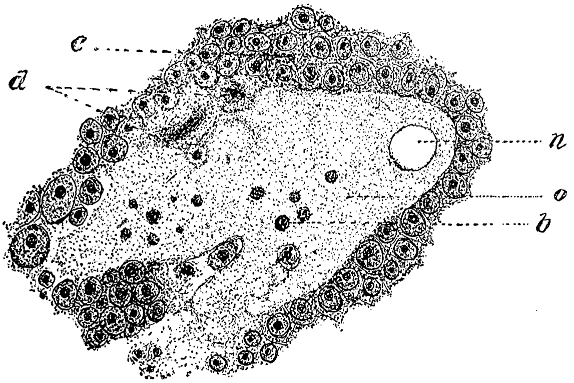

FIG. 12. — Absorption of primitive egg cells by growing ovum; *b*, nucleus of absorbed cell in state of disintegration; *d*, entire cells lying within the ovum; *c*, primitive egg cells; *n*, nucleus.

In regard to the process of absorption, there are two distinct views. In Doflein's words ('96, *p.* 1):—

"Die einen Forscher nehmen an dass die Eizelle die umgebenden Nährzellen aktiv auffrisst, sich von denselben, wie eine Amöbe von anderen Organismen ernährt. Dagegen behaupten Andere eine Auflösung der Nährzellen und eine Aufnahme derselben in flüssigem Zustand."

Doflein ('96) contends that the process of absorption described by Balfour and Tichomiroff as "*amœboides Fressen*" is decidedly incorrect and that the protoplasmic processes of the developing ova do not function as true mouths which bodily engulf the adjacent primitive ova. While my results in general confirm this view of Doflein's, nevertheless in one or two cases there seemed to be a distinct engulfment of the primitive ova. It appears to me that neither theory alone explains all the phenomena involved in the growth of the ovum, but that a combination of both theories would better explain the facts. My observations, however, lead me to agree with Doflein in his objection to the term "amoeboides Fressen." If we watch an Amœba in its movements, we will observe that when a process of the protoplasm presses against certain foreign particles of organic nature, they become sunk in the substance and pass gradually into the interior. Here they become surrounded by a little globule of watery fluid, a vacuole; and by degrees these particles partially or wholly disappear. All the matter which is capable of it becomes digested and assimilated by the protoplasm. It is very probable that the vacuole contains some ingredient of the nature of a ferment which is capable of acting upon these foreign substances and rendering them more soluble. These are the phenomena involved in the process of amœboid eating. Yet, while they agree in a few respects with those phenomena which are exhibited in the growth of the ovum, on the other hand, it seems to me that they present such fundamental differences as not entirely to warrant the statements of Balfour and Tichomiroff. In the first place, there is no formation of a vacuole about the absorbed cells, with the exception of, later on, a small one about their nuclei. I did not find these vacuoles in any sections of Corymorpha, but in examining some slides prepared by Miss Allen (:00) in her study of the development of *Tubularia crocea*, I found numerous cases of these vacuoles containing, from one to as many as seven or eight nuclei. These vacuoles however, were all found in ova which had begun to segment, and undoubtedly the same phenomenon would have presented itself in Corymorpha, if the material used had been of a later stage of development. Doflein ('96) describes the same thing in *Tubularia larynx*.

Furthermore, the cytoplasm of the absorbed cells simply mingles with that of the growing ovum, and undergoes no apparent change whatsoever. There is no process of absorption, the cell walls disappear gradually and the nuclei appear to have been carried along in all directions by a "streaming motion of the plasma of the ovum." While I could not observe such a process in the preserved material, the "general agreement of authors on this point" (as Doflein states) makes it quite certain that this phenomenon of amœboid movement does exist.

Miss Allen (:00) in her observation on *Tubularia crocea*, says that in numerous cases the outlines of the absorbed eggs could be distinguished in the protoplasm of the absorbing egg. In a very few favorable sections, I have been able to detect the outlines of these absorbed cells (Fig. 12, *d.*), but in most cases only the nuclei were distinguishable.

A great many of the primitive ova do not thus become absorbed, but remain scattered among the mature eggs in their original undeveloped state. Doflein suggests that possibly, after the larvæ have left the gonophore, these remaining germ tissue cells unite to form new eggs.

SUMMARY.

In summarizing the results obtained in this study, the following points should be noted :

1. Corymorpha, in keeping with its usual description, is a solitary form.

2. The rhizoidal filaments of attachment are formed as secretions from the papilliform processes.

Both filaments and papillæ are modifications of the same structure.

3. The central axis of the stem is filled with a mass of parenchyma-like cells in which is excavated a number of longitudinal canals. The longitudinal canals are extensions of the hydranth cavity.

4. Gland cells are highly developed in the hydranth cavity, but are entirely absent from the cœnosarcal canals. The function of digestion thus becomes localized in one portion of the enteric cavity while the cœnosarcal canals function as a circulatory system. A fairly well differentiated gastro-vascular system thus becomes developed.

5. The medusoid is developed from a bud which is formed by a simple outgrowth of the wall of the peduncle.

6. The chymiferous canals of the medusoid are formed by a fusion of the two layers of entoderm throughout the inter-radial areas.

7. The sex cells are derived from a plug of ectodermal cells formed at the apex of the bud.

8. The eggs develop by a process of absorption of the cells of the germinal tissue, thus giving rise to an amœboid syncytium.

9. The nuclei of the primitive germ cells persist for some time in this syncytium, but gradually disintegrate.

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